Vocational Aqualabs

Vocational Aqualabs - Vocational Generic Skills for Researchers

Experimental Design

Fundamentals of field design

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Education and Culture DG
Lifelong Learning Programme

Field Sampling Design

Considerations

- What are the sampling objectives of the trip?
- Where do you intend to sample? Which sites?
- What type of samples do you intend to take?
- What facilities are available for conducting the sampling?
  - *e.g.* What manpower is needed and / or available to assist in the sampling?
  - *e.g.* What sampling equipment is available or required to do the sampling?
  - *e.g.* Is the sampling limited by a budget? What finances are needed / are available?
- What analytical equipment do we need to work the samples up? What laboratory facilities (for example) are available?

Field Sampling Design - considerations

- We want to sample a lake to investigate a parasite problem?
- What are the **objectives** i.e:
  - Why are sampling this particular site?
  - How can I achieve it effectively?
- With this in mind, our objectives might be to:
  - Look at the site layout
  - Identify the parasite problem
  - Screening a number of fish for infectious agents
  - Establish the parasite prevalence
  - Sample enough stages / parasites to allow for a comprehensive taxonomic study ..... etc
  - Finally, we should be aware that many parasites are seasonal and so our sampling strategies should allow for this. Parasites may occur in lower numbers in certain seasons and therefore we have to increase our sample sizes.

Field Sample Design - considerations

- **Timing?**
  - **Event-driven.** Are we sampling in response to a particular event such as the death of fish – if this is the case, then we may have a narrow window in which to conduct our sampling, otherwise we miss finding out what was responsible for causing the mortalities.
  - **Environmental seasonality**. If we think about parasites again, some only occur in certain seasons – the hosts may be there all year round but the parasites may have a discrete season of occurrence. Our sampling may wish to monitor their numbers to make sure that they are not building up to levels that may threaten the health and welfare of fish stocks.
  - **Host seasonality**. Alternatively, the appearance of the host may be season, which is certainly true of some marine species which come into coastal waters to feed, breed or spawn. Other species may migrate as part of their life-cycle.
  - **Repeated sampling interval for the optimal resolution**. Thinking carefully about what you are wanting to sample will allow you to design a sampling schedule and how frequently you need to go sampling.

Field Sample Design - considerations

- **Sample selection**. How many samples do you need to take? Of what size? From where?
- **Capture method**. The method you use should take account of the samples you need and it does not affect your sample integrity.
  - e.g. When sampling parasites, fish caught in a gill net would struggle and thus dislodge skin parasites, or if the fish dies in the net the parasites may leave the fish to find another host. Whichever way if you are not careful these data cannot be used for quantitative analysis of parasites.
- **Sample number**. How many are needed to give you a statistically robust result?
- **Sensitivity of detection methods**. How appropriate are the methods / techniques you are using to measure the thing you are after?

Sample selection

- **Targeted samples:**
- Choice of particular animals for e.g. parasite collection, parasite identification (e.g. molluscs which are commonly the intermediate host for many parasite species).
- Not replicable (observers / time / space)
- Not useful for prevalence / abundance estimation

- **Single or multi-stage random samples:**
- All individuals in the population have an equal probability of being selected for e.g. screening.
  - Replicable
  - Useful for prevalence / abundance estimation

Targeted samples

- **“Which fish to sample?”** - This is perhaps the most important consideration. If you are, for example, conducting a routine health assessment of a stock of fish then your method of sampling must be random. Bias in your sampling could result in a misleading interpretation and caution is required.

Avoid:

- Fish drawn to food
- Heavily infected fish (known parasite)
- Fish near the surface
- Sampling sick fish
- Sampling dead fish
- Sampling big fish

You get the idea…….

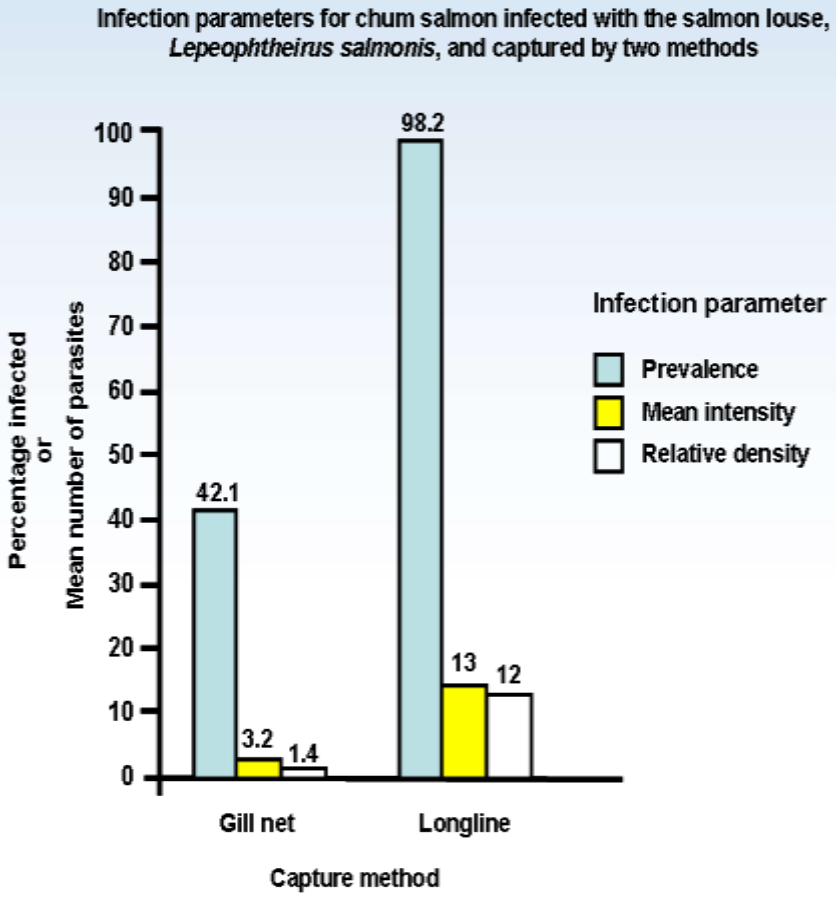
Random field sampling

Considerations:

- True random samples from the field are extremely hard to obtain, particularly from wild populations.
- On farms, harvesting / grading / restocking provide opportunities for good random sampling. Random number tables may be used to select the fish to be sampled with the order of capture / handling determining the number of each fish.
- Random samples from wild populations are often compromised by the capture method, sampling location etc.

Capture method

- Method of capture used for sampling can have a significant impact on the parameter you are trying to investigate.
- Look at the data here taken from the research of Nagasawa (1985).
- These data show how the sampling/capture method can affect interpretation of disease infection, potentially leading to erroneous conclusions on disease transmission.



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Field Surveys

- Sometimes we wish to test theories or hypotheses in the real world using actual effects and changes.
  - For example, we may want to investigate the effect of aquaculture discharges on the local and wider environments

- Field surveys must also be well designed to ensure that:
  - The results are meaningful and testable using statistical methods
  - Ensure there is no (or at least a minimisation of) biased within the results
  - Work within the available resources or budget of the study, i.e. available sampling and analytical effort.

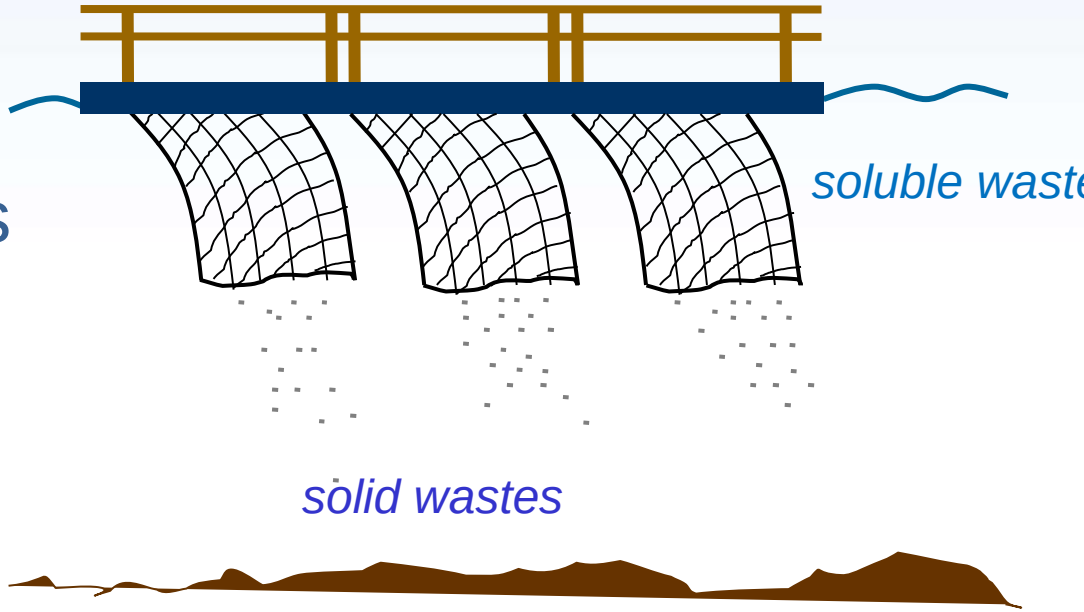
Field Survey - example

- Design and experiment to investigate the environmental impact of nutrient enriched wastes discharged from a marine cage fish farm.
- Hypothesis –
  - “Nutrient discharges cause significant effects on the physical, chemical and biological properties of the water column and seabed sediments”
- We must ask two initial questions:
  - What form is the waste?
  - What samples should be taken and from where?

Field Survey - example

- **First question answer -**
- Soluble nutrients which stay largely in the water column

  and
- Particulate nutrients which settle to the seabed.



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Field Survey - example

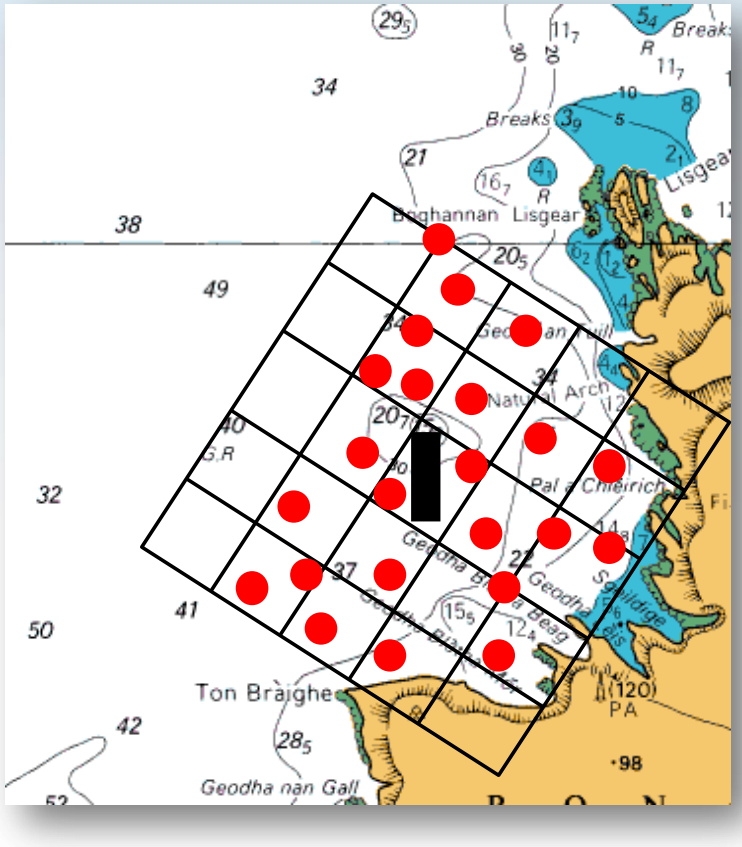
- **Question 2, part 1**
- Need to take samples from both water and seabed sediments

- **Question 2, part 2**
- Spatial component (where?)
- Three type of field design can be used
  - Randomised design
  - Even grid design
  - Targeted design

Field Survey - example

Randomised design

- Randomly selected grid coordinates around the fish farm
- Strongest statistically
- High effort



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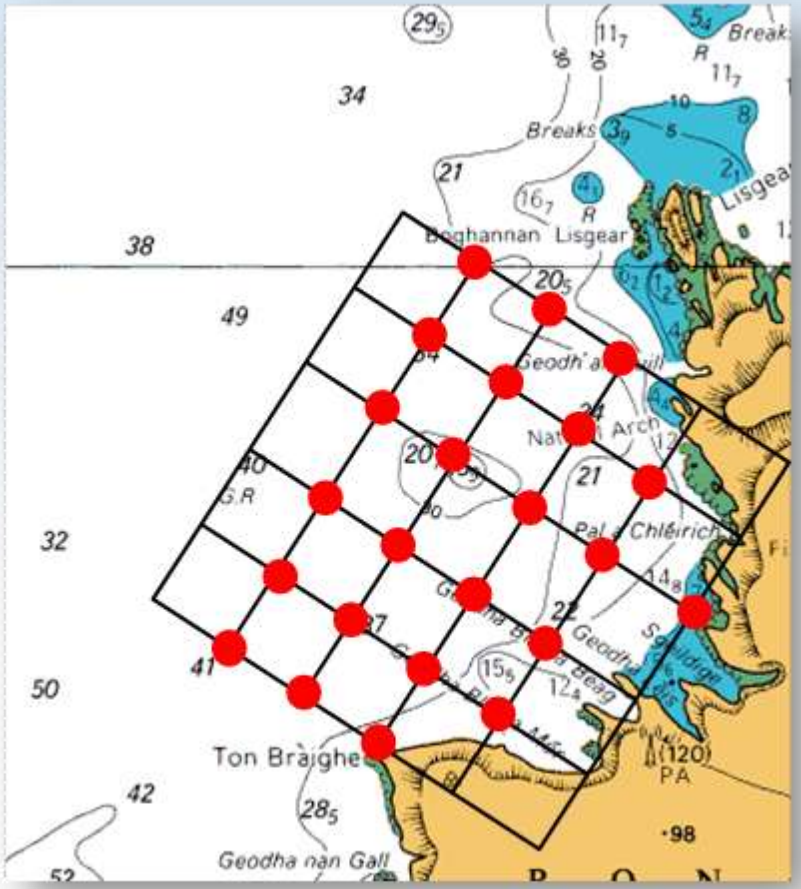
Field Survey - example

Grid design

- Evenly spaced sampling stations in a grid pattern
- Good statistically
- Covers wide spatial distribution
- Expensive
- High effort



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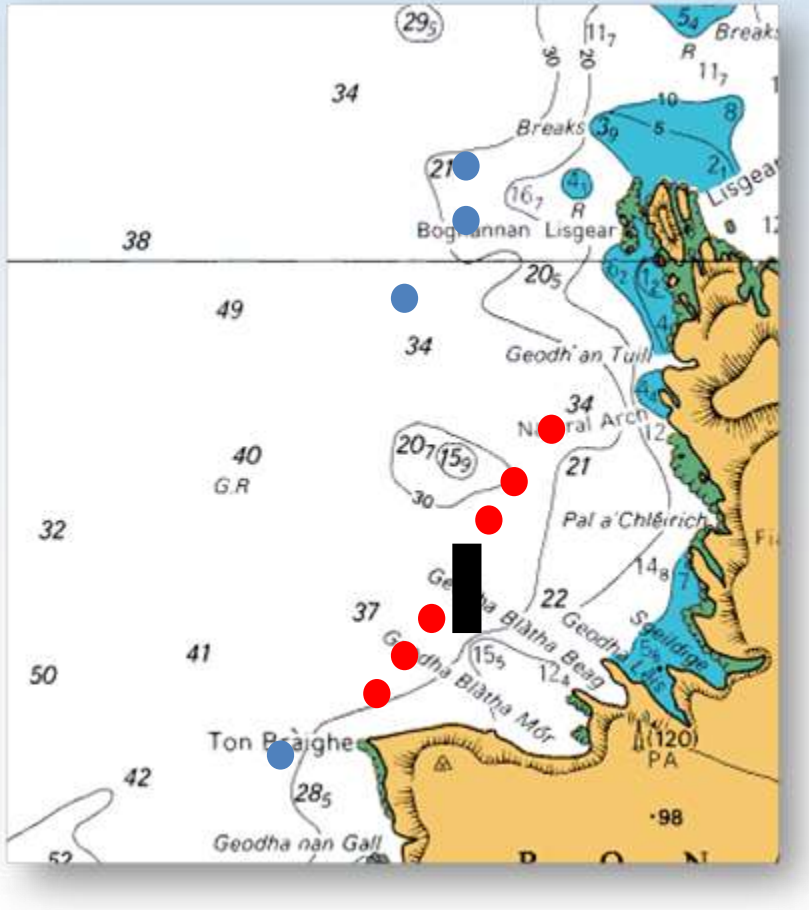
Field Survey - examples

Transect design

- Targeted to investigate a particular trend
- Best for point source effects
- Need additional information, i.e. Current speed and direction
- Statistically weaker
- Inexpensive



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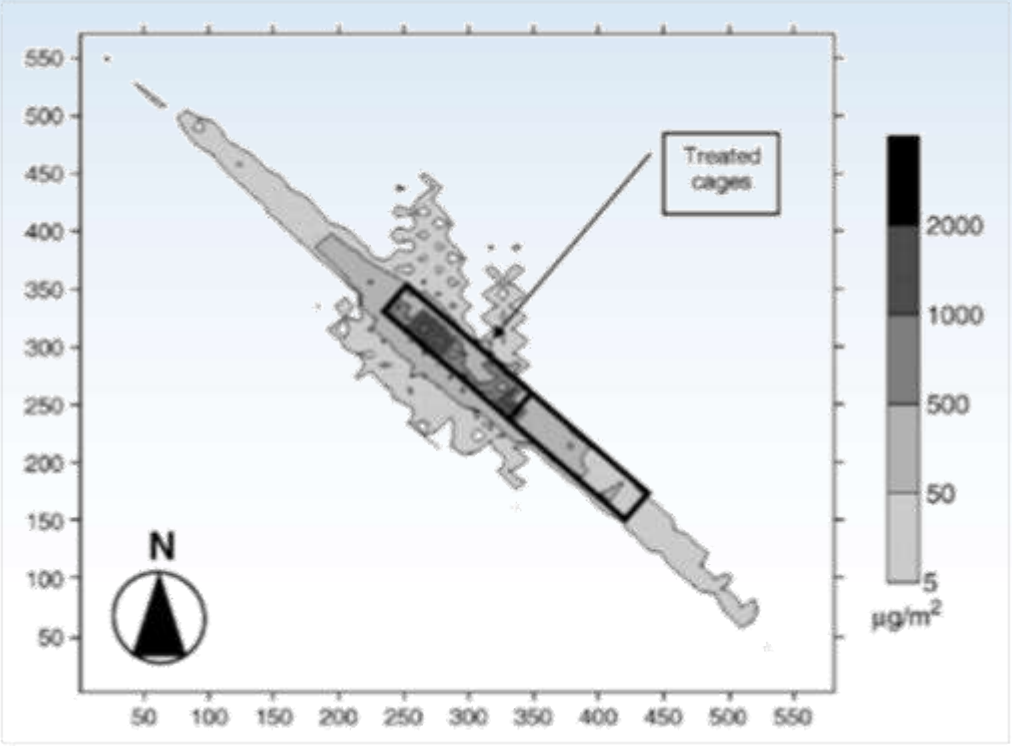
Field Survey - examples

Transect, e.g.

- Model to estimate the main areas of dispersion of fish cage wastes
- This allows effective positioning of survey transects.



(After Telfer et al, 2006)

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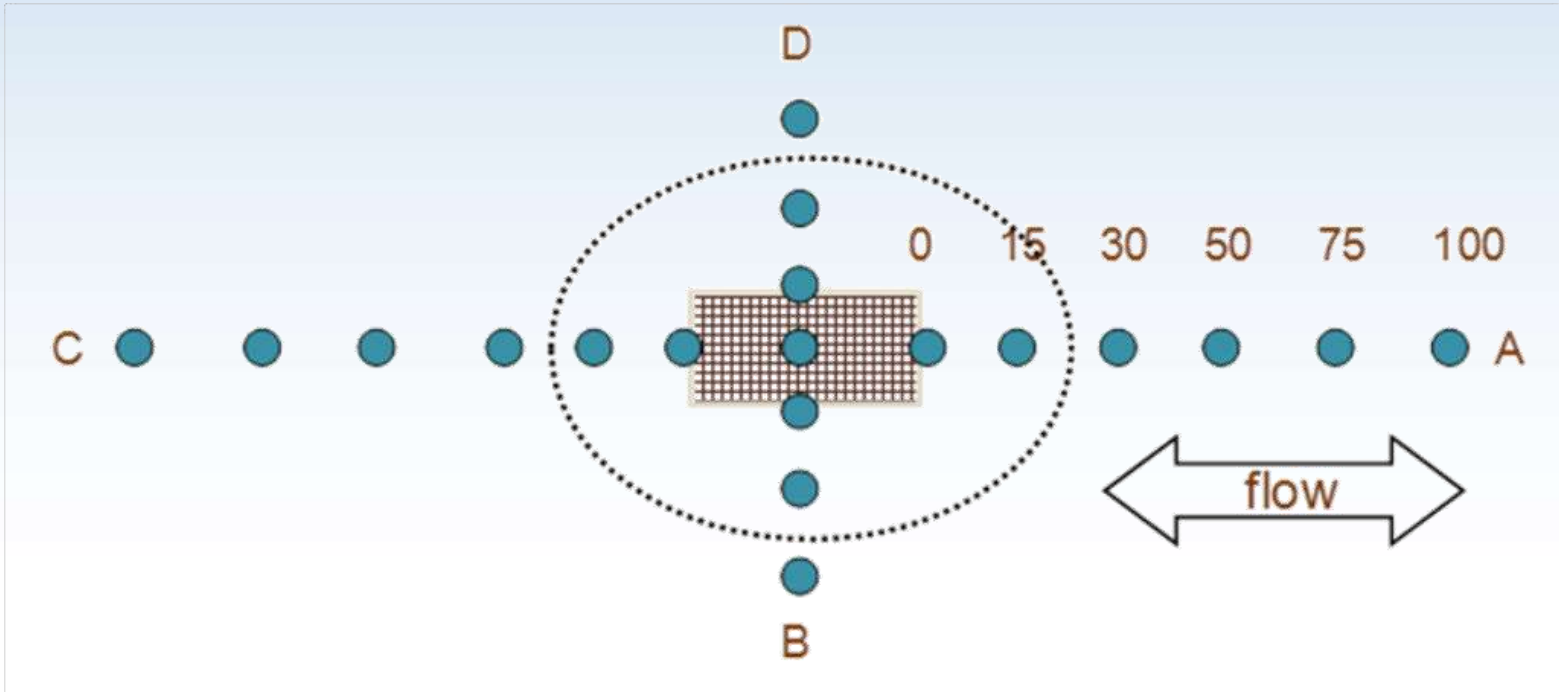
Field Survey - examples



Possible layout of sample stations along transects adjacent to a marine cage fish farm to investigate localised effects of wastes. Numbers are distance in metres.

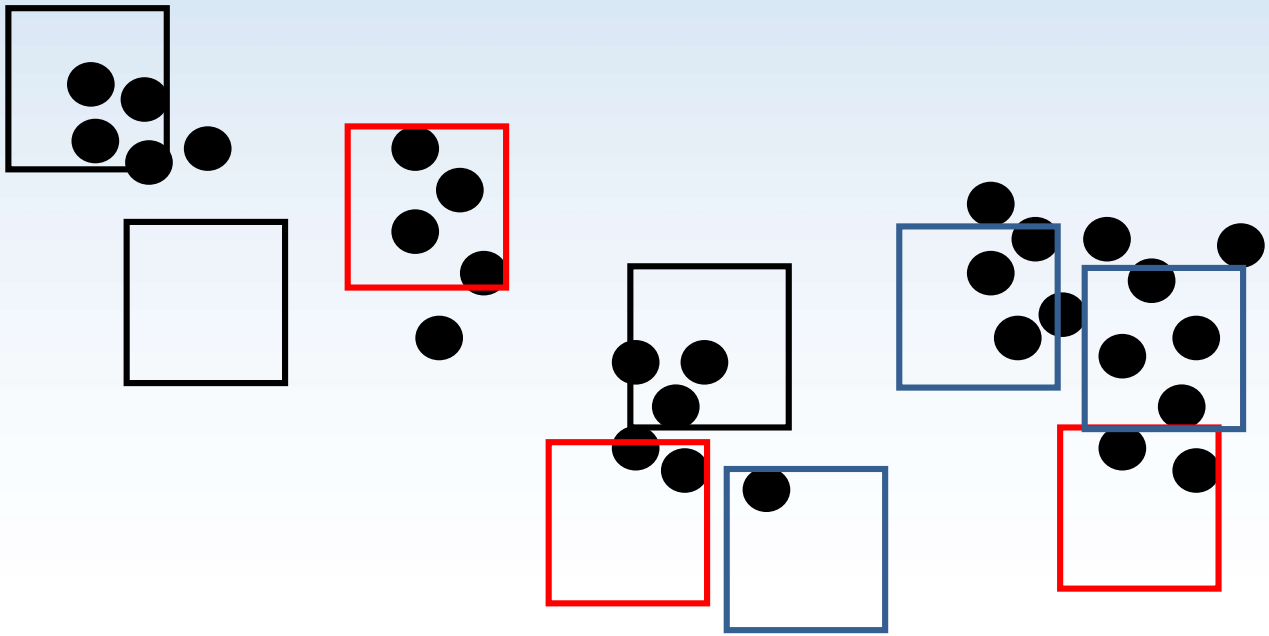
Importance of sample size

The large the sample size (replicates?) .....

- the more likely it is to be suitable for the most commonly used statistical methods
- the better your ability to detect low prevalence of a factor of interest
- the greater the precision of estimates
- the smaller the detectable difference between samples

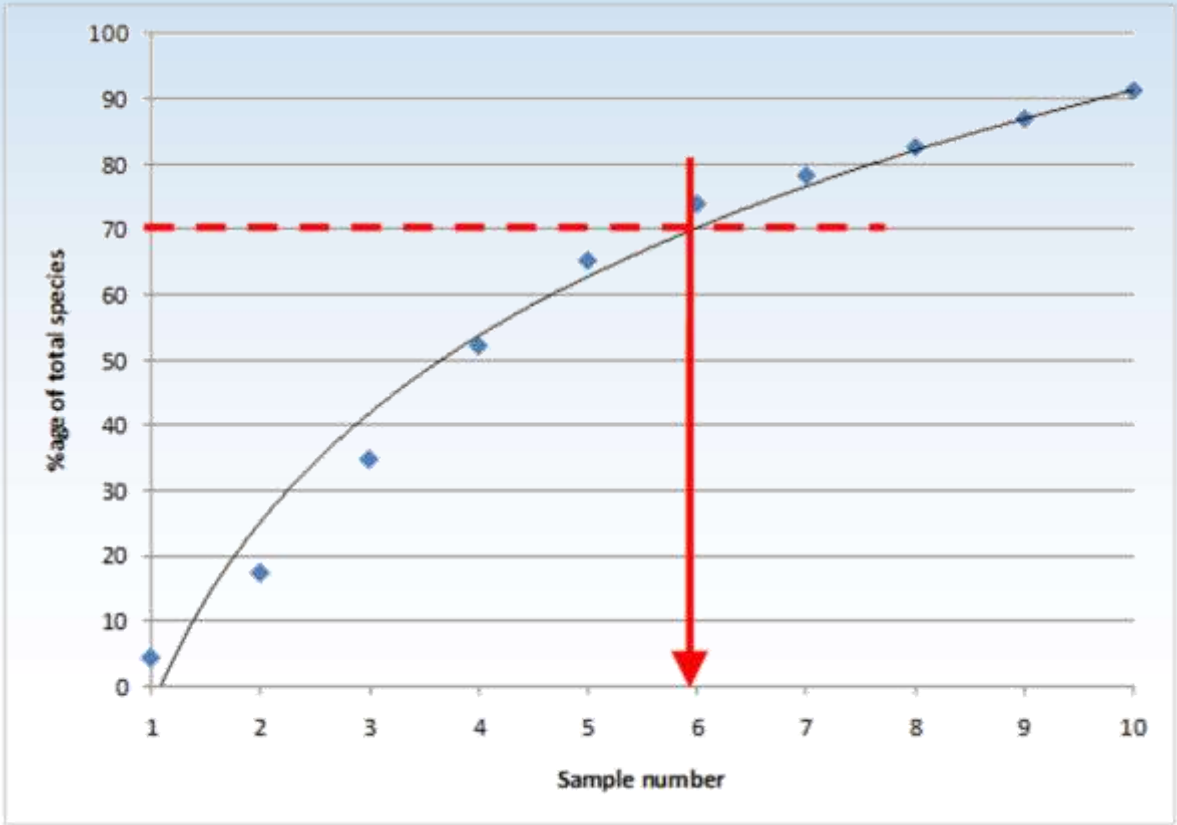
However, sample size may be limited due to operational considerations. Therefore these are often a compromise.

Sampling benthic organisms



Sampling for biological parameters such as species richness and composition, there are other confounding environmental factors. Benthic (sediment) organisms often exhibit what is known as "clumped", "patchy" or contagious distribution.

Sampling benthic organisms



How do we therefore make sure that we take enough samples to ensure we have an adequate representation of the species within the community? A species area curve – see that 6 samples will account for 70% of the total there.

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Review of sampling methods

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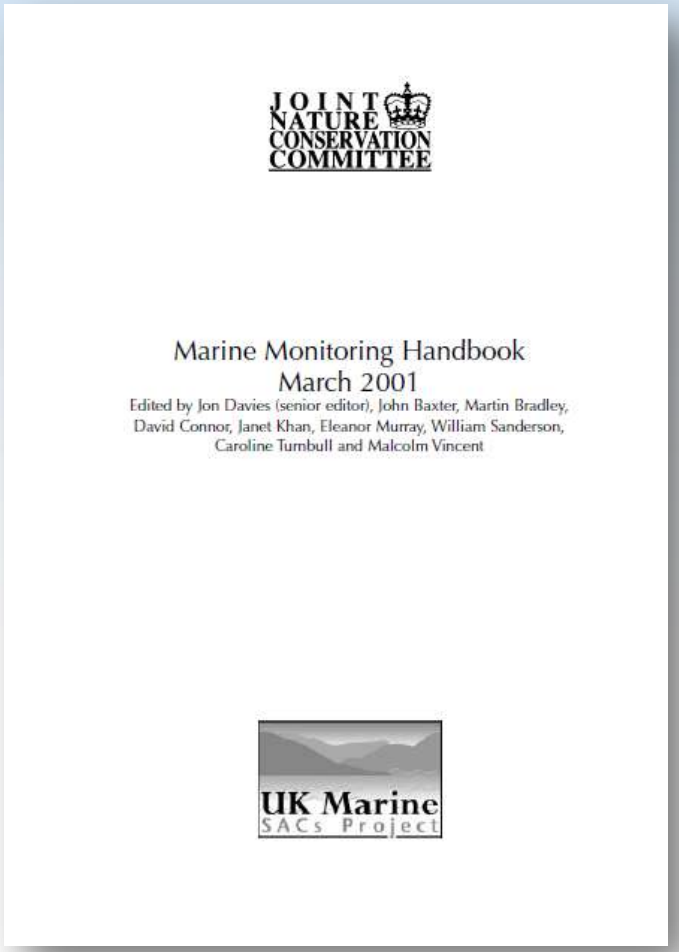
Review of sampling methods

Sampling methods

Many references available:

- Marine Monitoring handbook, 2001 (see over)
- Holme, N.A., & McIntyre, A.D. (1984) Methods for the study of Marine Benthos. IBP Handbook 16, 2nd edn. Blackwell Scientific Publication, Oxford.



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Sampling methods

Time series sampling (Monitoring)

- The same sampling methods and number of replicates at each sampling location should be used on each sampling occasion
- Apart from random sampling, as need as possible the same sample station locations should be used on each occasion to allow comparison.
- Pre-impact data should be collected from the same places (except for random designs) using the same methods, including at the reference stations for transect approaches – BASELINE DATA

Sampling methods

Baseline data

- Gives initial information on the present state of the environment over the area of investigation
- Can be used as the start for comparison of post- and pre-development (impact)
- Ideally should be done over a number of years before development – not just once

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Thank you

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